South Dakota Space Grant Consortium
South Dakota School of Mines & Technology
Edward F. Duke, Ph.D.
(605) 394-1975
http://sdspacegrant.sdsmt.edu
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The South Dakota Space Grant Consortium is a Capability Enhancement Consortium funded at a level of $430,000 for fiscal year 2011.

PROGRAM GOALS

Consortium Management: To ensure quality and fairness in all Consortium programs and alignment with the needs of NASA, the member and affiliate organizations, and the state of South Dakota.

Fellowship/Scholarship: To administer a fellowship/scholarship program that offers educational and research opportunities to students from diverse backgrounds who are pursuing degrees in fields of science, technology, engineering, and mathematics (STEM) that align with NASA's mission and those of SDSGC members and affiliates.

Research Infrastructure: To promote the improvement of research programs and capabilities of Consortium members with an emphasis on the fields of aerospace, earth science, and supporting STEM disciplines.

Higher Education: To build interdisciplinary programs related to NASA's Education Outcome 1 at the state's institutions of higher education and to support related programs that serve to strengthen STEM education in South Dakota.

Diversity of Participants: To model diversity in all Consortium programs and activities, with an emphasis on Native Americans, which make up the state's largest minority group.

Workforce Development: To use the Consortium's statewide network of scientists, engineers, and educators to provide talented students with a pathway to careers that will contribute to a highly-trained and diverse workforce for NASA and expand the nation's research and development capacity.

Longitudinal Tracking: To acquire and maintain accurate longitudinal data on all students and faculty who have received significant support from SDSGC in order to assess the impact of the support on their education, career, and professional development.

Minority Serving Institutions: To ensure that Minority-Serving Institutions in South Dakota, which are exclusively Tribal Colleges and Universities, are represented in the planning and implementation of all Consortium programs.
Precollege: To increase student awareness and access to education and career opportunities in aerospace, earth science, and supporting STEM disciplines.
Public Service: To enhance public scientific literacy in aerospace and earth science, to complement community efforts in STEM education, and to inspire citizens of diverse backgrounds through the excitement of scientific exploration and discovery.

PROGRAM/PROJECT BENEFIT TO OUTCOME (1, 2, OR 3)
The following highlights reflect the impact of SDSGC programs in support of NASA Education Outcome 1: *"Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals."*

Ryan Brown, a junior at the South Dakota School of Mines & Technology (SDSM&T) majoring in Computer Engineering, was accepted into a 15-week spring 2012 semester internship at NASA Johnson Space Center (JSC) under a $10,000 Space Grant stipend. Ryan previously had conducted a summer 2011 industry internship at Rockwell Collins under a $7,000 ESMD Space Grant stipend. During Ryan's spring 2012 internship, he applied for and was accepted into the JSC's co-op program while he completes his Masters degree at SDSM&T. Ryan was also instrumental in facilitating a program with JSC's Higher Education office where a NASA representative will come each year to SDSM&T's Career Fair, which will significantly strengthen SDSGC's pipeline to NASA. After graduating Ryan plans to work in the field of space exploration for NASA.

Daniel Nehlich, a junior at SD State University (SDSU) majoring in Physics, conducted a 15-week spring 2012 semester internship with NASA Johnson Space Center's Advanced Physics Propulsion Lab under a $10,000 Space Grant stipend. Daniel plans to pursue a Masters in Astronautical Engineering with an emphasis in propulsion. In February 2012 after the first month of his internship, Daniel wrote: *"It's been just over one month and I can say with conviction that this has already been one of the greatest experiences of my life. The people I've met have been awesome. The projects I've been able to see have been amazing. The value of this experience is incalculable. I have never loved a job more than this. I'm excited to go to work in the morning, and I'm satisfied when I leave work at night. And when I stop to think about where I am and what I'm doing, I feel like the luckiest guy in the world. Don't get me wrong, the job is tough ... some days are really frustrating, but the satisfaction of progress is wonderful. …"*

Anthony (Tony) Kulesa, a senior Civil Engineer at SDSM&T received a $7,000 Space Grant Undergraduate Research Stipend last year to fund his research project titled "Composite Preform Characterization." In January 2012, Kulesa applied to NASA's prestigious Space Technology Research Fellowship (NSTRF) Program offered through NASA's Office of the Chief Technologist and promoted by SDSGC to all of our Consortium's institutions of higher education. In April 2012, Tony was selected as one of only 50 such fellowship awardees. NASA awarded a year of NSTRF funding in the

amount of $66,000 to Tony and his advisor Dr. Marc Robinson for their research on composite materials for lunar structures.

PROGRAM ACCOMPLISHMENTS

The performance *Goals* for Fellowship, Research Infrastructure, Higher Education, Precollege, and Informal Education are listed above under "Program Goals." The specific *Performance Objectives* from Table G.3 "Summarized Table of Consortium Goals and SMART Objectives" included in SDSGC's FY2010 Program Plan that are applicable to the accomplishments listed below are given in *italics* at the start of each accomplishment.

NASA Education Outcome 1 Accomplishments

Fellowships/Scholarship

Annual Performance Objective: Statewide competition offered at all 10 higher education affiliates including three Tribal Colleges; emphasis on internships with NASA, aerospace industry, DUSEL, and EROS**. [At least 55 awards ($1,000-$12,000); all awardees enter longitudinal tracking system; at least 10% minority and 40% female; at least three NASA interns and five EROS interns]*

* DUSEL – Deep Underground Science & Engineering Laboratory, now referred to as Sanford Underground Research Facility (SURF)

** EROS – USGS Earth Resources Observation and Science Center

Eighty six (86) applications were received from students from six of the Consortium's universities for SDSGC's FY2011 Fellowship/Scholarship Stipend Program. The FY2011 "base award" budgeted $137,750 for fellowship/scholarship funds. SDSGC's Management Team reviewed the applications and in early June 2011, made offers to 53 students representing six universities. Eighteen awardees were graduate level (34%) and 35 undergraduate (66%). The Consortium exceeded its goal of 10% of its awards to minorities in terms of the number of awards and met the target in terms of the total amount of awards. Specifically, seven (13%) are minority students, five of which are Native American. Thirty-two percent (32%) of the total number and 34% of the total dollar amount of awards were provided to female students, which did not meet the targeted goal of 40% of awards to female students.

All of SDSGC's internship fellowships were budgeted under the Consortium's FY2011 "augmentation" funds. That fact is mentioned here to simply point out that SDSGC's objective of placing at least three NASA interns was greatly exceeded in that nine (9) student interns were placed at four NASA Centers and two (2) students placed at United Technologies Corporation aerospace industry companies during FY2011. Those 11 student internship awards, along with the interns placed at EROS, will be reported together under the FY2011 SDSGC "augmentation" report.

Research Infrastructure

Annual Performance Objective − Statewide competition for Program Initiation Grants for research development offered at all 10 higher education affiliates including three Tribal Colleges; emphasis on interdisciplinary research focused on NASA, DUSEL, or EROS priorities. [At least two awards for research ($5,000-$20,000)]

SDSGC annually supports Project Innovation Grants in the areas of Research Infrastructure, Higher Education and Precollege. Because these funds were budgeted under the FY2011 augmentation funds (~$19,000), the FY2011-funded Project Innovation Grant projects will be reported under the augmentation performance report. However, during the FY2011 program year in June 2011, SDSU submitted the final report on the "*Remote Sensing for Water Quality Monitoring and Watershed Assessment on Lake Traverse Reservation"* research project funded under SDSGC's FY2010 Project Innovation Grant program. During the summer of 2010, three student interns from Sisseton Wahpeton College (SWC), a Tribal College in northeast South Dakota, along with four researchers from SDSU engaged in a pilot project to assess the feasibility of using Landsat imagery to determine water transparency in reservation lakes in northeastern South Dakota.

Considerable progress was again made on the Deep Underground Science and Engineering Laboratory (DUSEL) effort (now termed SURF, as explained above) during 2011. The project is the most ambitious research infrastructure undertaking in South Dakota history, and SDSGC has played an active role through funding students and research projects. SDSGC funded several student research projects at DUSEL, as exemplified by graduate student Mark Hanhardt. A 2011 M.S. graduate in Physics from SDSM&T, Mark was a Space Grant fellow for two years prior to graduation. In October 2011, he accepted a position at the Soudan Underground Laboratory in Soudan, MN, were he works on projects involving dark matter and neutrino oscillations. While a graduate student at SDSM&T, Mark conducted extensive research at DUSEL through SDSGC affiliate Sanford Underground Laboratory. He worked on the Large Underground Xenon (LUX) Experiment. Mark built a fully-functional photomultiplier tube (PMT) laboratory which he used for LUX water shield PMT testing as part of the Long Baseline Neutrino Experiment, a joint project between SDSM&T and Fermilab near Chicago.

Building on the central role of physics in the state's research infrastructure plans, the Davis-Bahcall Scholarships were initiated by NSF in 2008 and augmented with SDSGC fellowship funding during FY2011. Ten (10) high school seniors and college freshmen spend one month of their summer at the Sanford Laboratory at Homestake. Then the students fly to Italy for a week of study at Gran Sasso National Underground Laboratory, currently the largest underground lab in the world. Finally, they study physics at Princeton University. The Davis-Bahcall Scholarship is named after Nobel Prize winner Dr. Ray Davis and Dr. John Bahcall, the two scientists most responsible for a revolution in the field of solar neutrino physics and neutrino astronomy. Three of the Davis-Bahcall college freshmen selected for the summer 2012 program will be funded directly by SDSGC, each with a stipend of $4,000.

Annual Performance Objective − Support collaborative research proposals in NASA areas. [At least one collaborative proposal submitted]
Although no data or outcomes specific to SD NASA EPSCoR research will be reported here in order to avoid duplication in reporting, Space Grant working in concert with SD NASA EPSCoR resulted in two new major research grant proposals being funded by

NASA in FY2011. Researchers from SDSGC affiliates SDSM&T, SDSU, OLC, and USD collaborated with researchers at NASA Ames Research Center and Kennedy Space Center in successfully proposing two new projects under the 2011 NASA EPSCoR Competition. The two funded research projects are titled *"Structural Thermal Insulation Composites"* and *"Cyanofactory Platform to Photosynthetically Produce Advanced Fuels and Chemicals, while Providing Bioregenerative Life Support Services."* Similarly, Space Grant assisted in an advanced technical workshop held in Rapid City, SD, in the fall of 2011 in support of a NASA EPSCoR research award on "Improved Thermal Management Systems using Advanced Materials and Fluids" (NNX09AU83A). The *"Carbon Nanomaterials and Applications Workshop"* featured 15 invited speakers including members of the National Academy of Engineering, the National Science Board, and representatives of NASA research centers, DOE national labs, and industry. Dr. Jing Li of NASA Ames Research Center delivered an invited talk on "Carbon Nanotube-based Nanotechnology for NASA Mission Needs and Societal Applications."

As a further example of the growing research collaboration between SDSGC affiliates and NASA, South Dakota researchers made a strong showing at Glenn Research Center's Space Photovoltaic Research and Technology Conference (SPRAT XXII), held Sept. 20-22, 2011. Five of the 35 technical talks were delivered by faculty and student members of the South Dakota team. The research is funded through a 2009 three-year NASA EPSCoR research award titled *"Development of an Advanced Photovoltaic Materials Research Cluster in South Dakota"* (award number NNX09AP67A).

Annual Performance Objective − Support Tribal College research roundtable in conjunction with NASA EPSCoR. [At least one Tribal College research roundtable]
As a result of the spring 2010 Tribal College research roundtable funded by SD NASA EPSCoR Research Infrastructure Development (RID) funds, two Tribal College Collaboration Grant proposals were received and one was selected by the SD NASA EPSCoR Steering Committee for funding during the FY2011 program year. The selected project titled "*Development of a Nanocomposite Research Program at Sinte Gleska University using 3D Simulation and Visualization as an Education and Research-Recruitment Tool"* will be conducted during the period March 2011 – May 2013. The project is carried out in connection with the FY2010 NASA EPSCoR Research Grant *"Enhanced Raman Detection of Minerals, Microbes, and Biomarkers through the Development of Advanced Plasmonic Nanomaterials"* (NNX10AN34A). The collaboration grant is designed to improve the research and educational infrastructure at two SDSGC affiliate Tribal Colleges: Sinte Gleska University (SGU) and Oglala Lakota College (OLC). The systems have been utilized in courses, workshops, and other research and educational events, and are used to help recruit Native American high school students into higher education. Fifteen SGU students took part in a two-day workshop on nanoscience and nanoengineering that was coordinated by faculty, research staff, and graduate students from the University of South Dakota, SDSM&T, and Augustana College.

Six pre-proposals were received under NASA EPSCoR's 2011 Minority-Serving Institution (MSI) Faculty Engagement Competition. The SD NASA EPSCoR Steering

Committee selected one of the six pre-proposals for full proposal status and submission to NASA. That proposal, titled *"Optimal Power and Relay Selection in Wireless Relay Networks,"* was selected for funding in the amount of $250,000 for the period May 2012 – May 2014. The project significantly improves research and education collaboration between electrical and computer engineers at OLC, SDSM&T, and SDSU. The research will be further coordinated with NASA JSC, JPL, and the Minority University Research and Education Program.

Higher Education

Annual Performance Objective − Statewide competition for Program Initiation Grants for course development offered at all 10 higher education affiliates including three Tribal Colleges; emphasis on NASA disciplines. [At least one award for course development ($5,000-$20,000)]

SDSGC annually supports Project Innovation Grants in the areas of Higher Education, Research Infrastructure, and Precollege. Because these funds were budgeted under the FY2011 augmentation funds (~$19,000), the FY2011-funded Project Innovation Grant projects will be reported under the augmentation performance report.

Annual Performance Objective − Support interdisciplinary student engineering design teams in NASA priority areas. [At least three engineering design teams]

SDSGC supported six multi-disciplinary university student teams to participate at national competitions in FY2011 including SDSM&T's Aero Design Team, Robotics Team, *Moonrockers* Lunabotics lunar regolith excavator team, Unmanned Aerial Vehicle Team, Programming Team, and Autonomous Underwater Vehicle Team. All of the SDSGC-supported teams have outreach programs to precollege students.

Eight of the ten SDSM&T 2011 *Moonrockers* team students and two advisors traveled to NASA KSC with Space Grant support to compete in the May 23-28, 2011, Lunabotics competition. The *Moonrockers* delivered 34 kg of regolith resulting in an 11th place finish for the amount delivered. At the upcoming May 2012 Lunabotics competition, three SDSM&T students from the *Moonrockers* team and their advisor will participate with Space Grant support in NASA's Lunabotics College Recruitment Event at KSC. The event will focus on connecting high school juniors and seniors with STEM education opportunities available at colleges and universities across the nation. During the FY2011 program year, the *Moonrockers* team conducted six outreach activities that reached 227 precollege students, 83% of whom were in middle school.

Annual Performance Objective − Support summer STEM programs for precollege students on college campuses with emphasis on Native American students. [At least four summer STEM precollege programs]

SDSGC supported the following five precollege STEM camps, all of which took place on college campuses.

For the 19th consecutive summer, the **"South Dakota Gaining Early Awareness and Readiness for Undergraduate Programs" (SD GEAR UP) Honors Program** was held on the campus of SDSM&T from June 4 – July 15, 2011. This six-week summer

residential college-preparatory program hosted 260 high school students from 24 Tribal schools in South Dakota. About 85% of the students are Native American and two-thirds are female. Of the students who graduate from the program, virtually 100% also graduate from high school, 85% attend college, and 7% enter the military. This year's curriculum included NASA's "Science, Engineering, Mathematics, and Aerospace Academy" (SEEMAA), and a presentation by SDSGC's Deputy Director Tom Durkin titled *"40th Anniversary of NASA's Apollo Mission."*

SDSGC again supported the **SDSU-Flandreau Indian School (FIS) Success Academy** by providing direct funds for ten FIS Success Academy high school seniors to enroll at SDSU during the 2010-11 school year. Nine of those 10 students subsequently enrolled at SDSU as college freshmen during fall 2011. The SDSU-FIS Success Academy is an early and intensive college preparatory program serving more than 200 Native American high school students each year. SDSGC's support of Success Academy began during the 2003-04 school year. As a result of these efforts, 101 FIS seniors have enrolled as concurrent high school students taking STEM courses at SDSU. Forty-five of these students subsequently enrolled at SDSU as true freshmen. Before Success Academy, about one student per year graduated from the Flandreau Indian School and attended South Dakota State University.

SDSU's 20th annual **Aerospace Career and Education (ACE) Camp 2011** camp was held on July 10-13, 2011, and hosted 10 high school students with SDSGC support. Since ACE Camp's inception in 1992, 420 students have completed the program, averaging 21 students per year. A detailed 16-page *ACE Camp 2011 Evaluation Report* dated Aug. 24, 2011, was prepared by SDSGC Program Evaluators at SDSU based on pre- and post-camp participant surveys.

With SDSGC support, SDSU's annual **Girls: Engineering, Mathematics and Science (GEMS)** one-day workshop for 8th grade girls was held on the campus of SDSU on March 24, 2012 and provided 45 girls an opportunity to explore interests in engineering, science and technology. Similarly, SDSU's Space Grant-supported **Ready SET (Science, Engineering & Technology) Go!** camp is a one-day, annual workshop for high school girls held in November on the SDSU campus, with 32 girls in 2011. It is modeled after the 8th grade GEMS camp with activities more suited to high school age students.

SDSGC sponsored two, week-long summer residential ***Space Adventures! Camps*** at SDSM&T for 24 middle school and 16 high school students in July 2011. In August 2011, the middle and high school 2011 Space Adventures Camps were evaluated by SDSGC's Program Evaluator resulting in a 21-page evaluation report titled *"South Dakota Space Adventures Camp Evaluation Report 2011."*

Considering SDSGC's support of Space Adventures! Camp and all other STEM summer camps at SDSM&T assisted by Space Grant (with the exception of SD GEAR UP reported separately above), SDSM&T's summer 2011 STEM precollege youth camps resulted in a 32% increase in summer campers over 2010 (from 282 to 374). Of the 374 precollege students attending summer 2011 residential camps at SDSM&T, 41 (11%)

attended solely as a result of Space Grant scholarships and would not have otherwise been able to attend. Of the 41 Space Grant scholars, 27 (66%) were middle school students.

In an additional Higher Education accomplishment, twelve undergraduate students from SDSM&T's chapter of Students for the Exploration and Development of Space (SEDS) along with their faculty advisor attended SpaceVision 2011 at the University of Colorado, Boulder, Oct. 27–30, 2011. SpaceVision is the largest student-organized space conference in the nation and is presented by SEDS. The SDSM&T chapter of SEDS was recently re-established with support of a 2010 Project Innovation Grant from SDSGC and three of the SEDS students who attended the 2011 conference are FY2011 Space Grant fellowship awardees. One female student wrote: *"SpaceVision 2011 was one of the best experiences I have ever had. We were able to meet so many important people in the space industry including CEOs, vice presidents, and astronauts. This conference made me realize how much I would like to have a career in this industry, …"*

NASA Education Outcome 2 Accomplishments

Precollege

Annual Performance Objective − Support statewide precollege robotics programs, including resources, teacher training workshops, and state competition. [At least 30 teams participate in SD FLL robotics state competition (400 students)]

Sixty-two middle and elementary school teams competed in the **3rd Annual South Dakota FIRST LEGO® League (FLL) Robotics Tournament** was held at SDSGC affiliate Augustana College in Sioux Falls, SD, in February 2012 with $15,000 in FY2011 base funding support from SDSGC and major efforts from the late SDSGC Associate Director Dr. Dan Swets. The number of students involved with the FLL activities in South Dakota has grown from 140 students in the 2008/09 season, to 520 in the 2011/2012 season. Next year, regional competitions will qualify teams to advance to the 4th annual SD FLL final competition in February 2013. Much of the success of this program is directly attributable to Space Grant and especially to SDSGC's Associate Director Dr. Dan Swets of Augustana College. SDSGC is committed to maintain core funding for this program that has now clearly taken on a life of its own through a high level of community support across the state.

Annual Performance Objective − Sponsor statewide competition for precollege STEM teacher grant. [At least one precollege teacher grant ($5,000)]

Kelly Lane Earth & Space Science Grant – This annual $5,000 grant is awarded by SDSGC to science or math teachers in South Dakota in recognition and support of outstanding teaching and innovative educational programs at the pre-college level in the fields of STEM. Six applications were received for FY2011 and the winner was Mr. Timothy Elseman of Custer High School in Custer, SD, for his project involving physics in the classroom. In December 2011, teacher Amber Stout of Jefferson Elementary School in Pierre, SD, submitted her final report on her Kelly Lane Earth & Space Science Grant project awarded last year titled *"Incubation in the Classroom."* She reported that direct student participants included 100 elementary students (75 third graders and 25 first graders). Students expanded their knowledge of life science, technology, and math as

they learned about the life cycle of birds through incubation. Six third grade state science standards and four math standards were met through this sustainable project that will be used for many years to come.

After receiving six proposals, SDSGC's annual $5,000 **Daniel Swets Robotics Materials Award** was announced in February 2012 at the South Dakota science and math teachers' annual conference. With an additional donation of $2,500 in robotics materials from LEGO Education North America in memory of Dr. Swets, SDSGC was able to provide two robotics materials awards to teachers Ann Anderson and Kristy Messner of Belle Fourche Middle School and to principal Linda Foos of Milbank School District. Dr. Swets and two other leaders in South Dakota robotics were tragically killed along with the pilot in a small airplane crash on December 10, 2011, on their way from Sioux Falls to Rapid City, SD, to assist eight teams in an "open practice" robotics session in preparation for the annual SD FLL tournament in February 2012. Immediately after the accident, SDSGC named its annual $5,000 robotics teacher award the "Daniel Swets Robotics Materials Award" in memory of the unprecedented enthusiasm and vision that Dr. Swets brought to the state of South Dakota in the field of robotics.

Annual Performance Objective − Support collaborative proposals for innovations in precollege STEM education. [At least one collaborative proposal]
Through collaboration of several affiliates, SDSGC successfully competed for one major and four smaller STEM precollege education awards. SDSGC affiliate SD Discovery Center (SDDC) successfully led a collaborative proposal submitted in February 2011 to **NASA's Summer of Innovation (SoI)** program and was selected for a $750,000 four-year grant, although the data and outcomes of that separate award are not reported here. Through the SoI program and with FY2011 Space Grant base award assistance, SDDC also created a recognition program called *"NASA SD Stellar Teachers"* and *"NASA SD Rising Star Students."* Under these programs, teachers and students are each granted the title and a recognition certificate when teachers complete 40 hours of professional development in STEM or when students acquire 40 hours of STEM curriculum outside of the school day. Additionally, with SDSGC base grant assistance, under the 1st round of NASA SoI "mini-grant" applications in summer 2011, South Dakota schools and STEM educational organizations received three of the 51 awards granted nationally. South Dakota was one of only five states to received three awards. SD submitted one application under the 2nd round of mini-grant applications in summer 2011 and it was awarded.

Additionally, the summer 2011 Space Observation, Learning, and Research (SOLAR) Institute was the last summer of a three-year NASA INSPIRE Collegiate Experience (Tier 2A) grant awarded to SDSGC in 2009 to increase the number of high school juniors interested in NASA STEM careers. Three universities in three states were awarded the three-year NASA INSPIRE grants. This year's two-week, STEM-focused, residential, college-preparatory summer 2011 SOLAR Institute was held from July 31 – August 13, 2011 at SDSM&T and hosted 30 exceptional high school juniors selected by NASA. The 2011 SOLAR Institute students were from among the following states: CT, CA, FL, GA, LA, MD, MI, MN, NC, NY, TX, UT, VA, and WI. SDSM&T was the university of

choice for almost half of the 30 students attending the 2011 SOLAR Institute. The students indicated that they heard about how wonderful South Dakota's program is from other members of the online INSPIRE community and that is why they chose SDSM&T. SDSGC has committed to funding a continuation of the SOLAR Institute during summer 2012 that will focus on SD students.

Annual Performance Objective − Inspire and motivate women, underrepresented minorities, and persons with disabilities into STEM careers. [Over 1,000 females and students from underrepresented groups participate each year through Women in Science Conferences, K-12 science fairs, ACE Camp, Flandreau Indian School Success Academy, SD GEAR UP, and related programs.]
Through its partnership with the SD Discovery Center, SDSGC continued to support six highly successful **Women in Science (WIS) conferences** held throughout the state during FY2011. WIS conferences reached 1,743 middle and high school girls in FY2011, an increase of 343 girls over FY2010. Of the 1,743 girls, 23% are minority (11% Native American, 7% Hispanic, and 5% other minorities), a 6% increase over FY2010. Additionally, 211 teachers, parents and volunteers participated in the events. NASA activities and programs were at the forefront of many of the FY2011 conferences. For example, Wendy Laurence, a NASA educator was the keynote speaker and a major presenter at the Pierre WIS Conference. Vanessa Hight, assistant coordinator for the SD NASA Summer of Innovation program, provided a teacher/parent training session on the use of NASA resources and opportunities to inspire students.

In addition to the precollege programs highlighted above, SDSGC headquarters staff provided an additional 11 precollege programs at schools and museums during FY2011 reaching 710 students and 55 teachers as direct participants: 85 elementary (12%), 517 middle school (73%), and 108 high school (15%). Of the total number of 710 students reached by headquarters staff presentations, 56% are Native American.

NASA Education Outcome 3 Accomplishments
Informal Education Programs (Public Service)
Annual Performance Objective – Partner with informal education affiliates to disseminate NASA content, share NASA educational resources, and host major NASA science education events. [15 informal education providers and 500 students share NASA resources; 150 teachers and 2,200 students participate in NASA science education events such as SD Space Days]
South Dakota Space Days 2011 was held on April 20-21, 2011 and consisted of four presentations by former NASA Astronaut Story Musgrave. Dr. Musgrave spoke to a capacity crowd at SDSGC affiliate the Journey Museum in Rapid City about his career and about his experiences with the famous 1993 Hubble Space Telescope Servicing and Repair Mission. He then spoke three times to high school students at Douglas High School in Box Elder, SD, which is next to Ellsworth Air Force Base. He spoke to 860 people; 685 students/staff at Douglas High School and 175 members of the public at the Journey Museum.

SDSGC headquarters staff provided an additional four NASA space-related informal education programs to 175 members of the general public during FY2011. Presentations were given at: A) Neutrino Days in Lead, SD (site of the Sanford Underground Research Facility) where SDSGC Deputy Director Tom Durkin's presentation on space exploration and the retirement of the U.S. Space Shuttle was recorded, transmitted, and archived over the internet as a *Science Café* by SD Public Broadcasting, B) two Kiwanis service clubs, and C) the Darton Geological Society at the Journey Museum.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Student Data and Longitudinal Tracking:
  Total Fellowship/Scholarship awards under SDSGC's FY2011 base grant = 53; 7 of the total awards were to underrepresented minority students. During the FY2011 program year, 55 students who were significantly supported from FY2006-FY2011 funds took their next step: 12 students are pursuing advanced degrees in STEM disciplines, 4 accepted STEM positions at NASA contractors, 1 accepted a position at NASA, 25 accepted STEM positions in industry, 1 accepted a STEM position in K-12 academia, 4 accepted STEM positions in academia, and 8 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award.

- Diversity:
  Three of 10 Higher Education affiliates are Tribal Colleges and Universities (TCUs) or minority-focused colleges. Two of three teacher awards went to females. Two of seven voting members of the SDSGC's management team were female during FY2011. For Outcome 1 higher education programs, 13% percent of the base grant fellowship/ scholarship awards went to minority students (exceeding SDSGC's goal of 10%) and 32% went to females. For Outcome 2 precollege programs, over 25% of the direct participants were minority students and over half were female (exact numbers to be reported at the end of the FY2011 program year in the Performance Data Request document when released by NASA). Diversity and gender statistics were not tracked for Outcome 3 public service programs.

- Minority-Serving Institutions:
  Minority-Serving Institutions: Two Consortium members are MSI Tribal Colleges (Sinte Gleska University and Oglala Lakota College) and one is a minority-focused Tribal College (Lower Brule Community College). In December 2011, SDSGC assisted Oglala Lakota College with its annual Lakota Winter Camp and Winter Gathering sponsored by OLC's Math and Science Department, American Indian Science and Engineering Society (AISES) Chapter, and the OLC NASA "Science Engineering and Mathematics Aerospace Academy" (SEMAA) Program. Also, in March 2012, SDSGC and OLC began discussing how SDSGC could collaborate with OLC's NASA SEMAA project which includes K-12 STEM training materials, robotics training (Lego NXT and We-Do), a "family café" that integrates Lakota culture and STEM, and an Aerospace Education Laboratory (AEL). The SEMAA AEL can accommodate classes up to 20 students and includes a flight simulator, a wind tunnel, and education in GPS/GIS/remote sensing, aviation, aircraft design, foil

design, flight planning, and weather prediction. The AEL lab reaches up to 350 Native American students per year.

As noted under Research Infrastructure, the SDSGC management team works closely with the SD NASA EPSCoR Steering Committee to enhance research collaborations with the Consortium's TCU's. In December 2011, six pre-proposals were received from SDSGC affiliates under the NASA EPSCoR 2011 Minority-Serving Institution (MSI) Faculty Engagement Competition. In April 2012, the project titled *"Optimal Power and Relay Selection in Wireless Relay Networks"* was selected for funding under the 2011 MSI Faculty Engagement Competition in the amount of $250,000 for the period May 2012 – May 2014. Also during FY2011, SDSGC researchers from SDSM&T, SDSU, Oglala Lakota College, and USD collaborated with researchers at NASA Ames Research Center and Kennedy Space Center in two successful SD NASA EPSCoR major research grants titled *"Structural Thermal Insulation Composites"* and *"Cyanofactory Platform to Photosynthetically Produce Advanced Fuels and Chemicals, while Providing Bioregenerative Life Support Services."* Similarly during FY2011, as a result of an earlier Tribal College research roundtable funded by SD NASA EPSCoR RID funds, a Tribal College Collaboration Grant project titled "*Development of a Nanocomposite Research Program at Sinte Gleska University using 3D Simulation and Visualization as an Education and Research-Recruitment Tool"* was selected by the SD NASA EPSCoR Steering Committee for funding during the during the period March 2011 – May 2013.

- NASA Education Priorities:
  NASA 2011 Education Priority Accomplishments*:*
  Hands-on student experiences in NASA-related STEM disciplines that incorporate real-life problem-solving needs were provided to the following six multi-disciplinary university student teams at SDSM&T that participated in national competitions during FY2011 with Space Grant support, several of which are summarized above under Outcome 1 Higher Education: 1) Aero Design Team, 2) Robotics Team, 3) Programming Team, 4) *Moonrockers* Lunabotics lunar regolith excavator team, 5) Unmanned Aerial Vehicle Team, and 6) Autonomous Underwater Vehicle Team. Similarly, authentic experiences were provided to precollege students through significant direct support from Space Grant as summarized above under Outcome 2 Precollege: 1) 520 middle school students who benefited from participating in the 3rd Annual South Dakota FIRST LEGO® League (FLL) Robotics Tournament, and 2) 1,743 middle and high school girls who attended six Women in Science Conferences in South Dakota.

  Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise – Through annual SD Space Grant funding, the SD Discovery Center (SDDC) has been able to establish on-going training relationships with several organization across the state of South Dakota, thereby helping to institutionalize NASA and STEM resources as part of the curriculum in these locations/organizations. In FY 2011, the following organizations participated in the training: A) Inspiring Students with NASA Resources - Sinte

Gleska University pre-service teachers (9 pre-service teachers), B) SD Talented & Gifted Teachers Association and librarians from approximately 90% of SD libraries (11 teachers and 91 librarians), and C) educators from over 90% of 21st Century Community Learning Centers serving Title I schools (121 teachers). Additionally, continuing an established relationship, the SD Discovery Center provided NASA resources training at the February 2011 SD science and math teachers' conference in Huron, SD.

During summer 2011 with Space Grant assistance, Augustana College provided four middle school teacher-training workshops in robotics to 20 teachers and four pre-service teachers. The Journey Museum provided one three-day "Journey into Space" teacher workshop for 18 middle school teachers devoted solely to NASA STEM curriculum in July 2011.

Summer 2011 opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines and interest in STEM careers included the following four camps which are detailed earlier in this report: 1) the week-long 2011 Aerospace Career and Education (ACE) Camp held on the campus of SDSU with 10 high school students, 2) the two-week NASA SOLAR "Space Observation, Learning, and Research" Institute held on the campus of SDSM&T with 30 high school students, 3) the six-week South Dakota GEAR-UP program held on the campus of SDSM&T with 260 high school students from Tribal schools (85% of whom are Native American), and 4) the Flandreau Indian School Success Academy held on the campus of SDSU which is an intensive STEM-focused college-preparatory program for over 200 Native American high school students, 10 of whom received direct support from Space Grant. These four programs fulfilled one of SDSGC's Annual Precollege Performance Objectives to *"Support summer STEM programs for precollege students on college campuses with emphasis on Native American students. [At least four summer STEM precollege programs.]"*

Community Colleges – SDSGC did not have significant collaborative programs during the FY2011 program year with two year community college affiliates Lake Area Technical Institute and Lower Brule Community College.

Aeronautics research – South Dakota NASA EPSCoR researchers, along with SDSGC affiliate Raven Industries and other industry partners are collaborating with NASA Ames in a new three-year project titled *"Cyanofactory Platform to Photosynthetically Produce Advanced Fuels and Chemicals, while Providing Bioregenerative Life Support Services."* This project will help the Aeronautics Research Mission Directorate (ARMD) address the goal of providing renewable, energy dense biofuels in a sustainable manner, while sequestering CO_2.

Environmental Science and Global Climate Change – In October 2011, an educator from SDSGC affiliate the Journey Museum attended a two-day NASA Earth Ambassador Climate Day Training Session in Greenbelt, MD.

Diversity of institutions, faculty, and student participants – See "Diversity" above.

Support of innovative research infrastructure activities to enable early career faculty to focus research toward NASA priorities – As a partial result of an earlier Project Innovation Grant of $18,600 awarded by SDSGC during FY2010 to early career faculty member Dr. Mark Robinson of SDSM&T for his research infrastructure project titled *"Vacuum Assisted Resin Transfer Molding (VARTM) Process Simulation for Compressible Preform Materials,"* Dr. Robinson worked with his advisee and Space Grant Fellow Anthony Kulesa in applying for a NASA Space Technology Research Fellowship (NSTRF) program award of $66,000 in January 2012, and they received it. Their research focuses on composite materials for lunar structures.

IMPROVEMENTS MADE IN THE PAST YEAR

Strategic Plan Objective B.3.2 − Enhance faculty and undergraduate/graduate student development through planning visits, internships, and fellowships at NASA Centers and EROS. [At least two faculty or students from SDSGC affiliates will participate in NASA educational programs each year.]

In an effort to expose more students to NASA opportunities, SDSGC supported ten undergraduate students and two faculty members from SDSM&T to visit Goddard Space Flight Center on Oct. 17-18, 2011. The high-achieving students, who had been selected from a pool of 30 applicants, ranged from freshman through junior level and represented nine different degree programs. Three are FY2011 South Dakota Space Grant Consortium fellowship awardees. Among the highlights of the visit was a last-minute schedule change to accommodate a lunchtime lecture by Nobel laureate John Mather after which the students were able to meet with Dr. Mather. The students also attended a special presentation on NASA educational opportunities including internships and co-ops and received detailed guidance on submitting applications through the OSSI SOLAR system, and one of the students subsequently obtained a summer 2012 internship at JPL. Chemical Engineering student Haley Dunn wrote: *"This trip really opened my eyes to all of the possibilities for jobs I will have as a chemical engineer and how I can have a role in something huge, such as the JWST. I'm now looking forward to taking an internship with NASA to experience what it's like working for them, and I'm eager to learn more about NASA as a whole."* Mechanical Engineering student Eric Figuracion said: "*... I didn't realize there were so many ME's designing and building for NASA. I am definitely going to be applying for NASA internships and SAIC."* Industrial Engineering student Rhianna Hoffman said: *"This was an incredible experience. The biggest thing that I noticed and took away from visiting NASA was how happy every employee seemed to be there. ... The NASA people didn't have to go to a job--they went to follow their passions each day. Yes; I will be applying for an internship at NASA."* Chemical Engineering student Kati Johnson said: *"I loved being able to step into the integrated labs where all of the ideas begin. It was neat to see the scientists and engineers at their best. Everything was so interesting, and I absolutely loved learning all about the theories they have about space. I ended up researching a whole bunch of topics when I got home! I learned so*

much and am so thankful for all of the people who put so much time and effort into making our day fabulous. It was an honor to meet Dr. Mather and to watch his presentation on the James Webb Space Telescope." Computer Engineering and Computer Science student Steven Gates said: *"This trip definitely changed my opinion of NASA for the better, and has gotten me to consider a career with NASA. That wasn't something I had really thought about before this trip."* Direct outcomes include one student internship, several planned internship applications, and a faculty collaboration on a NASA Research Opportunities in Space and Earth Sciences (ROSES) proposal.

Other improvements made during FY2011 include a major shift in emphasis on NASA internships. The new, proactive approach resulted in 11 internship placements (9 at NASA Centers and two at aerospace industries). This compares to only four internship placements during FY2010.

SDSGC has already seen a long-term benefit from the new emphasis on NASA internships. For example, as a result of a spring 2011 internship at JSC: 1) one student has already been admitted to the co-op program, and 2) plans are in place for JSC representatives to attend the 2012 fall career fair at SDSM&T and to make special presentations to minority and Native American student organizations.

In the absence of any state aerospace industries, SDSGC in 2011 established two major partnerships with outside aerospace-focused groups. Partnership with L-3 Communications West (Salt Lake City) included five summer 2011 internships, two fellowships in the robotics MS program at SDSM&T, support for middle school girls' STEM camps, and significant hardware donations to the SDSM&T robotics laboratory. Partnership with the Connecticut Space Grant resulted in two United Technologies Corporation aerospace-oriented internships.

A 2011 SDSGC Project Initiation Grant helped SDSM&T reestablish its chapter of Students for the Exploration and Development of Space (SEDS). Five SEDS students are FY2011 Space Grant fellows. The chapter has become exceptionally active in space-related projects and outreach including the Lunabotics *Moonrockers* team, attendance at the 2011 SpaceVision conference hosted by the University of Colorado-Boulder on October 27-30, 2011, with 12 students from SDSM&T's SEDS chapter attending, and two student members receiving and accepting NASA Center internship and co-op offers.

South Dakota was selected in FY2011 as a pilot state for Pathevo STEM career and education planning software in partnership with Owen Software.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

SDSGC is a statewide network of 20 organizations from education, industry and government. The Consortium's eight-member Management Team consists of representatives of a cross section of the membership including SD School of Mines & Technology (the Lead organization), SD State University, Augustana College, University of South Dakota, USGS Earth Resources Observation and Science (EROS) Center, South

Dakota Discovery Center, the Journey Museum, and an ex-officio member who is Vice President of Research for the South Dakota Board of Regents. The full membership consists of the following list of educational, industrial, and government affiliates including the type of institution and the affiliate's role in SDSGC project execution.

Educational Affiliates

- South Dakota School of Mines and Technology (Lead Institution, state university BS-PhD, science and engineering; administration of Consortium's involvement in all Outcome 1, 2 and 3 programs)
- South Dakota State University (state university BS-PhD, agricultural and STEM institution; management in Outcome 1 higher education/research and Outcome 2 precollege robotics and other STEM programs)
- Augustana College (four-year private liberal arts and professional college; management in Outcome 1 higher education/research and Outcome 2 precollege robotics and other STEM programs)
- University of South Dakota (state university BS-PhD, medicine, law, fine arts, business; management in Outcome 1 higher education/research programs)
- Black Hills State University and Center for the Advancement of Mathematics and Science Education (four-year, state liberal arts institution; Outcome 2 pre-service education)
- Dakota State University (state university, Associates-PhD, computer management; limited involvement in Outcome 2 higher education)
- Oglala Lakota College (Tribal College, AA-MS with STEM majors; Outcome 1 higher education/research)
- Sinte Gleska University (Tribal College, four-year institution; Outcome 1 higher education/research and Outcome 2 precollege STEM programs)
- Lower Brule Community College (minority-focused, two-year college)
- Lake Area Technical Institute (technical institute, Associate of Applied Science degrees, robotics and aviation maintenance; Outcome 1 higher education)
- South Dakota Discovery Center and Aquarium (science center; management in Outcome 2 teacher-training and precollege robotics and other STEM programs including management of 2011 Summer of Innovation Grant)
- The Journey Museum (museum; management in Outcome 2 precollege planetarium, robotics, and other STEM programs and Outcome 3 public service astronomy and earth system science programs)
- Badlands Observatory (private observatory, astronomical research/education; Outcome 1 higher education and astronomical research)
- Black Hills Astronomical Society (astronomical society; Outcome 3 public service astronomy programs)
- Kirby Science Discovery Center (science center and museum; Outcome 2 precollege and Outcome 3 public service STEM programs)

State and Federal Government Affiliates

- Sanford Underground Research Facility at Homestake (a state organization under the management of the SD Science & Technology Authority; Outcome 1 physics research and higher education internships, Outcome 2 precollege STEM programs)

- USGS Earth Resources Observation and Science "EROS" Center (data management, systems development, and research field center; Land Processes Distributed Active Archive Center for NASA's Earth Observing System; management of Outcome 1 higher education and research programs in remote sensing)

Industrial Affiliates

- Raven Industries (engineered films, high-altitude balloons, GPS products; NASA contractor; Outcome 1 research and development in aerospace, higher education student internships)
- RESPEC (consulting & services: engineering, IT, water & natural resources; Outcome 1 research in remote sensing and higher education student internships)
- Science Applications International Corporation "SAIC" (scientific, engineering, and technology applications company; NASA contractor; management in Outcome 1 research in remote sensing and higher education student internships)

* L-3 Communications West, Salt Lake City, UT – a non-affiliate industry "sponsor" of SDSGC (aerospace, communications, and electronic systems government contractor; Outcome 1 research and development, and higher education student internships)